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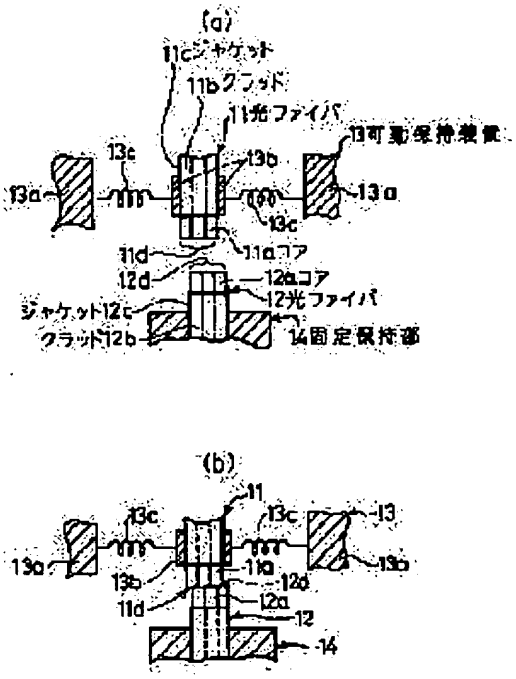
(54) METHOD FOR OPTICALLY COUPLING OPTICAL PARTS

(57)Abstract:
PURPOSE: To provide an optical coupling method by which optical coupling is efficiently performed without high accurate alignment, as an optical coupling method for optical materials by which optical elements such as an optical waveguide, an optical fiber, a laser diode and a photodiode are mutually optically coupled.
CONSTITUTION: The optical fiber 11 is held by a movable holding device 13, the optical fiber 12 is held by a fixed part 14, and the optical coupling surface 11d of the optical fiber 11 is allowed to abut on the optical coupling surface 12d of the optical fiber 12, then the optical coupling parts 11d and 12d are melted and welded by an arc discharge device. At such a time, the optical coupling surfaces 11d and 12d are automatically aligned by the holding device 13, and optically coupled.



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[Date of registration]

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* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the optical coupling approach of an optic, and relates to the optical coupling approach of the optic which carries out optical coupling of the optical elements of each other, such as optical waveguide, an optical fiber, a laser diode, and a photodiode, especially.
[0002] In recent years, the method of performing easily optical coupling between optics, such as an optical fiber and an optical element, is demanded with development of the optical-information-processing fields, such as optical communication and an optical interconnection.
[0003] However, on the other hand, the optical coupling between optics is asked for high joint effectiveness, and in order to acquire high joint effectiveness, while it is necessary to fully adjust electromagnetic-field distribution of the light between optics and the path of an optical coupling side is made in agreement in a part for the joint between optics, it is necessary to make an imperfect alignment, an include-angle gap, etc. small. When joining an optic comrade, it is necessary to carry out alignment of the plane of composition to altitude, and for that, this makes optical coupling between optics difficult. Therefore, in order to perform optical coupling between optics easily, it is necessary to be able to perform alignment between the planes of composition of an optic easily.
[0004]
[Description of the Prior Art] Drawing 14 shows process drawing of a conventional example. 1 and 2 show an optical fiber among this drawing. Optical fibers 1 and 2 are considered as the configuration which surrounded the perimeter of Cores 1a and 2a with clad 1b which has a larger refractive index than Cores 1a and 2a, and 2b. When carrying out optical coupling of an optical fiber 1 and the optical fiber 2, as shown in drawing 14 (a), an optical fiber 2 is fixed to a fixed part 3, and an optical fiber 1 is fixed to the stage 4 in which highly precise positioning is possible to a fixed part 3.
[0005] Next, while an operator looks at microscope 5 grade, a stage 4 is moved, and highly precise positioning is performed so that the core 1a end face of an optical fiber 1 and the end face of core 2a of an optical fiber 1 may be in agreement, as shown in drawing 14 (b).
[0006] After positioning, as shown in drawing 14 (C), melting arrival of the part for a joint was carried out by the arc discharge equipment 6 grade.
[0007]
[Problem(s) to be Solved by the Invention] However, since highly precise positioning was needed, the optical coupling approach of the conventional optic had the trouble of optical coupling between optics being unable to carry out easily.
[0008] This invention was made in view of the above-mentioned point, and aims at offering the optical coupling approach of an optic that optical coupling effectiveness can be performed highly, easily [optical coupling / between optics].
[0009]

[Means for Solving the Problem] In the optical coupling approach of an optic that this invention combines optically a base material, the 1st optic which comes to form the optical coupling section in one, and a base material and the 2nd optic which comes to form the optical coupling section in one Said the 1st optic and said 2nd optic are held free [migration] relatively. The optical coupling side of the optical coupling section of said 1st optic, The optical coupling side of the optical coupling section of said 2nd optic is made to counter mutually, and it comes to carry out melting arrival of the optical coupling side of the optical coupling section of said 1st optic, and the optical coupling side of the optical coupling section of said 2nd optic.

[0010]

[Function] An optical coupling side is carried out melting arrival, and optical coupling of the 1st optic and 2nd optic is carried out. When an optical coupling side fuses, surface tension works into the fused part. Since the 1st optic and 2nd optic are relatively held movable at this time, when surface tension works to a fusion part, the 1st optic and 2nd optic move relatively. In order to work so that the surface area may generally be made into min, surface tension moves the 1st optic and 2nd optic so that the surface area of the fusion part may serve as min. Since it is considered to be the case where there is no gap in a part for a bond part that the surface area of a fusion part serves as min when the 1st optic and 2nd optic join together by the minimum distance therefore, optical coupling effectiveness will be combined in the best condition.

[0011] Thus, even if there is a gap in the 1st optic and 2nd optic, alignment is automatically carried out by the surface tension at the time of melting, and optical coupling effectiveness can join together in the good condition.

[0012]

[Example] Drawing 1 and drawing 2 show optical coupling process drawing of the 1st example of this invention. 11 and 12 show the optical fiber used as the 1st optic and the 2nd optic among this drawing. Optical fibers 11 and 12 surround Clads 11b and 12b and Clads 11b and 12b which surround the cores 11a and 12a in which light is confined, and Cores 11a and 12a to concentric circular to concentric circular, and consist of jackets 11c and 12c which protect a fiber front face. The refractive index n11 of Cores 11a and 12a consists of larger ingredients than the refractive index n12 of Clads 11b and 12b, and total reflection of the light by which incidence is carried out from a fiber end face is carried out in the interface of Cores 11a and 12a and Clads 11b and 12b, it is shut up in core 11a and 12a, and spreads the inside of a fiber.

[0013] In addition, the photoconductive wave ingredient which carries out melting arrival as an ingredient of Cores 11a and 12a and Clads 11b and 12b is used.

[0014] Although melting arrival is carried out with heating, and it will not be limited to use light as a photoconductive wave ingredient if it is a transparent ingredient, especially an organic material and a glass ingredient are desirable. For example, as an organic material, thermoplastics, such as polymethylmethacrylate, polystyrene, polyester, a polycarbonate, polyolefine, a styrene-methylmethacrylate copolymer, a styrene acrylonitrile copolymer, the Polly 4-methyl pentene -1, and a polyvinyl chloride, can be used, and after melting arrival, it is the purpose which improves thermal resistance and mechanical strength, and heat or photo-setting resins, such as an epoxy resin, polyimide, cross-linking polyester, cross-linking polyacrylate, and silicone resin, can be used. Furthermore, heat or photopolymerization nature monomers, such as styrene, methacrylate, acrylate, an allyl compound, and an isocyanate compound, can be used. A polymerization initiator may be suitably added so that a polymerization may begin promptly by heat or light in those cases. Moreover, a suitable additive may be used in order to adjust physical properties, such as viscosity of an ingredient, melting temperature, a refractive index, and transparency, and weld becomes possible by raising viscosity in that case, even if an ingredient is a liquid. Furthermore, you may be the resin and the mixed constituent of a monomer which were raised until now.

[0015] Soda glass, Pyrex, a quartz, etc. can be used as a glass ingredient. Moreover, a suitable additive

may be used in order to adjust physical properties, such as melting temperature of an ingredient, a refractive index, and transparency.

[0016] An optical fiber 11 is fixed to the movable supporting structure 13. The movable supporting structure 13 combines fixed part 13a and attaching part 13b holding an optical fiber 11 by spring 13c, and holds attaching part 13b free movable to fixed part 13a. It is fixed to attaching part 13b, and an optical fiber 11 is held movable to fixed part 13a.

[0017] The optical fiber 12 is considered as the movable configuration to the fixed attaching part 14 held at a fixed condition, and the movable supporting structure 13 is considered as the configuration in which positioning with 11d (end face of core 11a and clad 11b) of optical coupling sides of an optical fiber 11 and 12d (end face of core 12a and clad 12b) of optical coupling sides of an optical fiber 12 is possible.

[0018] In performing 11d of optical coupling sides of an optical fiber 11, and 12d [of optical coupling sides of an optical fiber 12] optical coupling, it moves the movable supporting structure 13 to the fixed attachment component 14, and 11d of optical coupling sides of an optical fiber 11 and 12d of optical coupling sides of an optical fiber 12 are made to contact mutually so that at least 10% or more of the area may lap as shown in drawing 1 (b). Fixed part 13a of the movable supporting structure 13 is fixed in the place where the optical fiber 11 and the optical fiber 12 contacted. At this time, it is not necessary to position so that a mutual end face may be correctly in agreement.

[0019] Next, as shown in drawing 2 (a), a part for a 11d of optical coupling sides of an optical fiber 11 and 12d [of optical coupling sides of an optical fiber 12] joint is heated with the heating apparatus 15 using arc discharge etc., and melting of core 11a and the core 12a is carried out.

[0020] Cores 11a and 12a and Clads 11b and 12b fuse, and surface tension acts on the front face of Clads 11b and 12b by unifying. Surface tension acts to make surface area of the joint side face of Clads 11b and 12b as small as possible. If the center line of core 11a and the center line of surface area with Clads 11b and 12b of core 12a correspond, it will serve as min. For this reason, force which makes in agreement the center line of core 11a and core 12a will act on Cores 11a and 12a and Clads 11b and 12b.

[0021] Here, an optical fiber 12 is fixed by the fixed attaching part 14, and an optical fiber 11 is held at movable attaching part 13b, and is made movable. Therefore, the force of making in agreement the center line of an optical fiber 11 and an optical fiber 12 acts on an optical fiber 11, an optical fiber 11 moves in the direction of arrow-head X, and the center line of an optical fiber 11 and an optical fiber 12 is in agreement. Here, by stopping heating, an optical fiber 11 and an optical fiber 12 can be combined, after the center line has been in agreement. After the center line of an optical fiber 11 and an optical fiber 12 has been in agreement, since there are not an imperfect alignment and an include-angle gap in the optical coupling sides 11d and 12d, the joint effectiveness of light will be in a high condition. Thus, hold by the movable supporting structure 13 which holds an optical fiber 11 movable, and 11d of optical coupling sides and 12d of optical coupling sides of an optical fiber 11 are made to contact, and since alignment is automatically carried out by carrying out melting arrival by the surface tension at the time of melting arrival, even if it does not do a highly precise alignment activity, optical coupling with high optical coupling effectiveness can be performed.

[0022] In addition, it is a hydrophobic ingredient (it is what has - OH radical and -COOH radical in a molecule with an organic material) about Cores 11a and 12a and Clads 11b and 12b. Polyvinyl alcohol, polyphenol, polyvinyl FUCHIRARU, a polyvinyl formal, these copolymers etc. -- being shown -- a configuration or hydrophobic processing (it is coating to a front face about a canal nature ingredient) -- carrying out -- Jackets 11c and 12c -- a hydrophilic ingredient (it is what has -(few) F without - OH radical and -COOH radical in a molecule with an organic material) for example, the thing which a fluororesin, polystyrene, a polycarbonate, silicone resin, etc. are shown, or is done for hydrophilic processing (it is coating to a front face about a hydrophilic ingredient) -- a hydrophilic ingredient and a hydrophobic ingredient -- mutual -- parents, since it is ugly Cores 11a and 12a and

Clads 11b and 12b which Cores 11a and 12a and Clads 11b and 12b did not spread in a jacket 11c end face, and continued optically are formed.

[0023] Drawing 3 shows the sectional view of the 2nd example of this invention. 16 and 17 show 16a among this drawing, and an optical waveguide plate and 17a show a clad. Base materials 16a and 17a correspond to the clads 11b and 12b explained by drawing 1 and drawing 2 , and optical waveguides 16b and 17b consist of ingredients corresponding to Cores 11a and 12a. From base material 16a and 17a front face, two or more optical waveguides 16b and 17b have projected. Base material 16a is held at movable attaching part 18a which constitutes the movable maintenance stage 18. Base material 17a is held on the fixed maintenance stage 19.

[0024] By making two or more optical waveguide 16b and two or more optical waveguide 17b counter, and carrying out melting arrival, as drawing 1 and drawing 2 R> 2 explained, alignment is automatically performed by the surface tension produced at the time of melting of optical waveguides 16b and 17b, optical coupling of the optical waveguides 16b and 17b is carried out, and efficient optical coupling is carried out. In addition, in this example, although the optical waveguide plate 16 is held on the movable maintenance stage 18, the optical waveguide plate 16 may be laid in the state of un-fixing so that the mutual optical waveguides 16b and 17b may counter on the optical waveguide plate 17, and melting arrival may be performed. Since the optical waveguide plate 16 is in the condition of not fixing, it moves on the optical waveguide plate 17, and alignment is performed automatically.

[0025] Drawing 4 shows the perspective view of the 3rd example of this invention to the sectional view of the 3rd example of this invention, and drawing 5 . The optical waveguide plate with which 21 become the 1st optic, and the optical waveguide plate with which 22 becomes the 2nd optic are shown among this drawing.

[0026] The optical waveguide plate 21 is considered as the configuration in which optical waveguide 21b was formed on base material 21a. Optical coupling section 21c is formed in the location which should perform optical coupling on optical waveguide 21b of the optical waveguide plate 21. After optical coupling section 21c consists of same ingredients as optical waveguide 21b and forms optical waveguide 21b in base material 21a, it is applied and formed.

[0027] The optical waveguide plate 22 is considered as the configuration in which optical waveguide 22b was formed on base material 22a. Optical coupling section 22c is formed in the location corresponding to optical coupling section 21c formed on optical waveguide 21b of the optical waveguide plate 21 on optical waveguide 22b of the optical waveguide plate 22. Optical coupling section 22c consists of same ingredients as optical waveguide 22b, and is formed by applying on optical waveguide 22b.

[0028] Drawing 6 shows optical coupling process drawing of the 3rd example of this invention. First, as shown in drawing 6 (A), the photoconductive corrugated plate 22 is fixed to an abbreviation horizontal so that optical coupling section 22c may turn to the upper part, and it lays so that 21d of optical coupling sides of optical coupling section 21c and 22d of optical coupling sides of optical coupling section 22c of the photoconductive corrugated plate 22 may carry out abbreviation opposite of the photoconductive corrugated plate 21 mutually on the photoconductive corrugated plate 22, as shown in drawing 6 R> 6 (B). In addition, 21d of optical coupling sides and 22d of optical coupling sides may shift a little at this time.

[0029] Next, as shown in drawing 6 (C), melting arrival of the optical coupling sections 21c and 22c is carried out, and optical waveguide 21b and optical waveguide 22b are combined. Since the photoconductive corrugated plate 21 was only laid on the photoconductive corrugated plate 22 at this time, when the optical coupling sections 21c and 22c fuse, it is automatically positioned with that surface tension, and optical coupling of the optical coupling sections 21c and 22c can be carried out certainly and efficient.

[0030] Drawing 7 shows the perspective view of the 4th example of this invention. 50 show a

photoconductive corrugated plate among this drawing. The photoconductive corrugated plate 50 comes for a base material 51 top to form optical waveguides 52a and 52b.

[0031] When the optical coupling part of optical waveguides 52a and 52b etches a base material 51 by etching etc., a projection, optical coupling side 52a-1, and 52b-1 are formed from base material 51 front face.

[0032] In optical coupling side 52a-1, it is a photodiode PD 1. Optical coupling is carried out and it is a laser diode LD 1 in optical coupling side 52b-1. It considers as the configuration which carries out optical coupling.

[0033] Drawing 8 shows optical coupling process drawing of the 4th example of this invention. In addition, photodiode PD 1 And laser diode LD 1 Since the optical coupling approach is the same, it is a laser diode LD 1 here. The optical coupling approach is explained.

[0034] First, as shown in drawing 8 (A), the photoconductive corrugated plate 50 is laid so that optical coupling side 52b-1 may become an abbreviation horizontal.

[0035] next, it is shown in drawing 8 (B) -- as -- laser diode LD 1 10% or more of the optical coupling side 53 -- optical coupling side 52b-1 and ****** of optical waveguide 52b -- it lays in the free condition like.

[0036] Next, the optical coupling section 54 is heated by the heating approach mentioned above as shown in drawing 8 (C). At this time, it is LD1. Since it is laid in the free condition on b-optical coupling side 521, It is a laser diode LD 1 by the surface tension produced in the optical coupling section 54 when the optical coupling section 54 fuses with heating. It aligns automatically to optical coupling side 52b-1. As shown in drawing 8 (D), it is a laser diode LD 1. The optical coupling side 53 and optical coupling side 52b-1 of optical waveguide 52b are in agreement, and melting arrival is carried out. Thus, laser diode LD 1 Since it cannot shift and optical coupling of the optical waveguide 52b can be carried out, certainty and efficient optical coupling can be performed.

[0037] The perspective view of the 5th example of this invention is shown in drawing 9 . For the inside of this drawing, and 61 and 62, a photoconductive corrugated plate and 63 are an optical fiber and PD1. Light emitting diode is shown. This example is the photoconductive corrugated plate 61, an optical fiber 63, and light emitting diode PD1 while carrying out optical coupling of the photoconductive corrugated plate 52 and the photoconductive corrugated plate 61. Optical coupling is carried out.

[0038] The photoconductive corrugated plate 62 comes to form optical waveguide 62b in base material 62a, and on optical waveguide 62b, optical coupling section 62c projects it from optical waveguide 62b, and it is formed. Optical coupling section 62c applies the same ingredient as optical waveguide 62b, and is formed.

[0039] Optical waveguide 61 comes to form optical waveguide 62b in base material 62a, and it carries out optical coupling to the photoconductive corrugated plate 62. there are optical waveguide 61b-2 formed on optical waveguide 61b-1 which boils on the other hand and is penetrated from the whole surface of the photoconductive corrugated plate 61, and the whole surface in optical waveguide 61b.

[0040] optical waveguide 61 -- optical coupling section 61c-1 forms b-1 by applying the same ingredient as optical waveguide 61b-1 to the whole surface of the photoconductive corrugated plate 61 -- having -- optical coupling section 61c-1 -- an optical fiber 63 and light emitting diode PD2 Carrying out optical coupling, on the other hand, the photoconductive corrugated plate 61 comes out, and optical waveguide 61b-1 carries out optical coupling to optical waveguide 62b-1 of the photoconductive corrugated plate 62.

[0041] Optical coupling of optical waveguide 61b-2 is carried out to optical waveguide 62b-2.

[0042] Optical coupling of the photoconductive corrugated plate 61 and the photoconductive corrugated plate 62 is carried out efficient according to the process explained in the 3rd example. Moreover, optical coupling of the optical waveguide 61 is carried out to optical coupling section 61c-1 efficient at a process which explained the optical fiber 63 in the 1st example. Moreover, light emitting

diode PD2 Optical coupling is carried out to optical coupling section 61c-1 efficient at the process explained in the 4th example. It can also perform easily that carry out the laminating of two or more optics, and they carry out optical coupling as mentioned above. Drawing 10 shows the perspective view of the 6th example of this invention. 71 show a photoconductive corrugated plate among this drawing. The photoconductive corrugated plate 71 comes to form optical waveguide 71b in base material 71a, and optical waveguide 71b forms projection and optical coupling section 71c from the base material 71a end face. Optical coupling section 71c is formed by etching for example, a base material 71a end face. In addition, optical coupling section 71c may be formed by applying.

[0043] In optical coupling section 71c, they are an optical fiber 72 and a laser diode LD 2. Optical coupling is carried out.

[0044] Drawing 11 shows optical coupling process drawing of the 7th example of this invention. An optical fiber 72 and laser diode LD 2 Since optical coupling is carried out at the process of abbreviation identitas, only the optical coupling process of an optical fiber 72 is explained here.

[0045] First, it is ******** so that at least 10% of an optical coupling side may counter mutually with optical coupling section 71c as are shown in drawing 11 (A), and an optical fiber 72 is held by the movable attaching part 73 which makes an optical fiber 72 movable in the direction of arrow-head Y with the same configuration as the movable supporting structure 13 explained by drawing 1 , and abbreviation and it is shown in drawing 11 (B).

[0046] Next, as shown in drawing 11 (C), melting arrival of an optical fiber 73 and the optical coupling section 71c is carried out. At this time, since it is held movable in the direction of arrow-head Y, automatic alignment is carried out by surface tension at the time of melting arrival, and optical coupling of the optical fiber 72 is carried out certainty and efficient. Drawing 12 shows the perspective view of the 7th example of this invention. 81 show a photodiode array among this drawing, and 91 shows a photoconductive corrugated plate. The photodiode array 81 comes to form two or more photodiode 81b on semi-conductor substrate 81a. The photoconductive corrugated plate 91 comes to form optical waveguide 91b on base material 91a corresponding to photodiode 81b.

[0047] Optical coupling section 81c is applied to photodiode 81b. Optical coupling section 81c consists of thermoplasticity or photoresist polymer material.

[0048] Surface treatment section 91c to which surface treatment, such as a hydrophilic property in which surface treatment differs from the perimeter corresponding to optical coupling section 81c, or hydrophobicity, was performed is formed in the photoconductive corrugated plate 91.

[0049] In addition, even if both the photodiode array 81 and the photoconductive corrugated plate 91 perform surface treatment, it is good. Moreover, the optical coupling section may also be formed not only in the photodiode array 81 side but in the photoconductive corrugated plate 91 side, or you may form in both the photodiode array 81 and the photoconductive corrugated plate 91.

[0050] Furthermore, surface treatment is good also as a configuration performed to the perimeter instead of an optical coupling side.

[0051] Drawing 13 shows optical coupling process drawing of the 7th example of this invention.

[0052] First, as shown in drawing 13 (A), the photoconductive corrugated plate 91 is laid in an abbreviation horizontal so that optical waveguide 91b may turn to the upper part, and as shown in drawing 13 (B), the photodiode array 81 is laid so that optical coupling section 81c may counter on the photoconductive corrugated plate 91 at optical waveguide 91b.

[0053] Next, as shown in drawing 13 (C), melting of the optical coupling section 81c is carried out. If optical coupling section 81c fuses, the photodiode array 81 will move in the direction of arrow-head X with the surface tension, positioning with optical coupling section 81c and surface treatment section 91c is performed, optical coupling section 81c and surface treatment section 91c carry out melting arrival, and as shown in drawing 13 (D), optical coupling of the photodiode array 81 and the photoconductive corrugated plate 91 is carried out.

[0054] As for the FUWATO diode array 8 and the photoconductive corrugated plate 91, positioning is

automatically performed by the above processes, and optical coupling is performed certainty and efficient.

[0055] In addition, the optic in which optical coupling is possible is not restricted to what was raised in the 1st thru/or the 7th example by the optical coupling approach of this invention.

[0056] Moreover, it is not restricted to what also raised the combination of an optic in the 1st thru/or the 7th example.

[0057]

[Effect of the Invention] Since the surface tension committed in case melting arrival of the 1st and 2nd optics is carried out by holding relatively the 1st and 2nd optical members which are going to carry out optical coupling movable can perform alignment automatically like **** according to this invention, highly precise alignment becomes unnecessary and it has the features of being able to perform efficient optical coupling easily.

[Translation done.]

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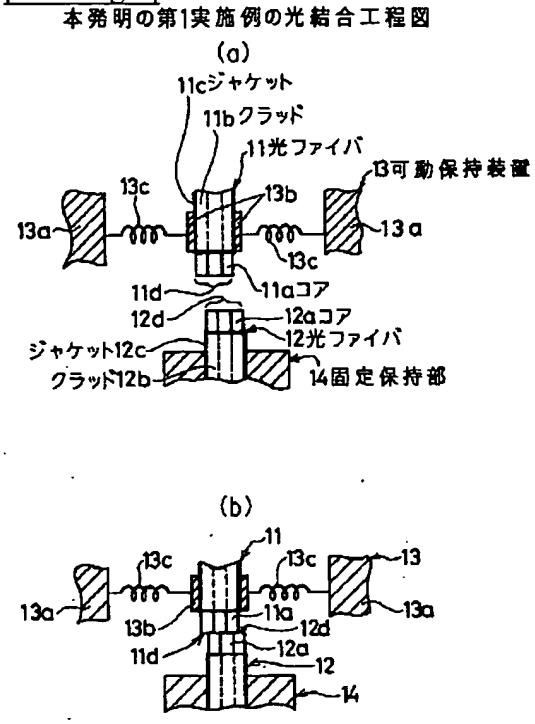
DRAWINGS

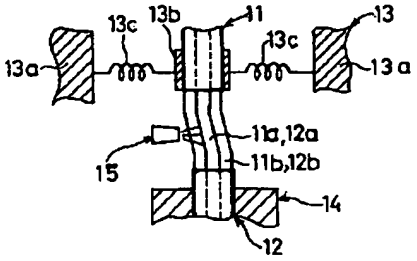
[Drawing 1]



[Drawing 2]

本発明の第1実施例の光結合工程図

(a)



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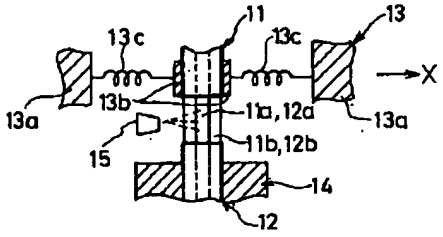
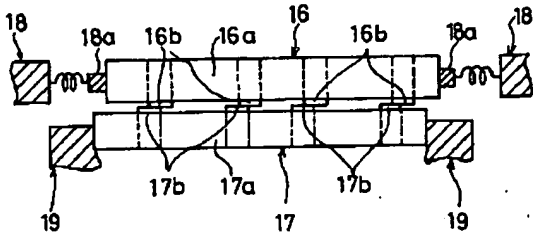


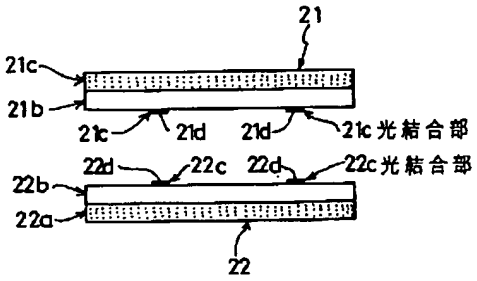
[Drawing 3]

本発明の第2実施例の断面図



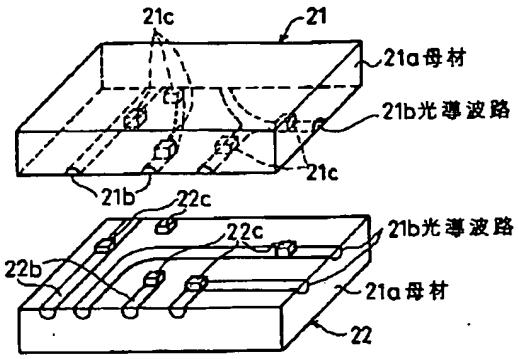
[Drawing 4]

本発明の第3実施例の断面図



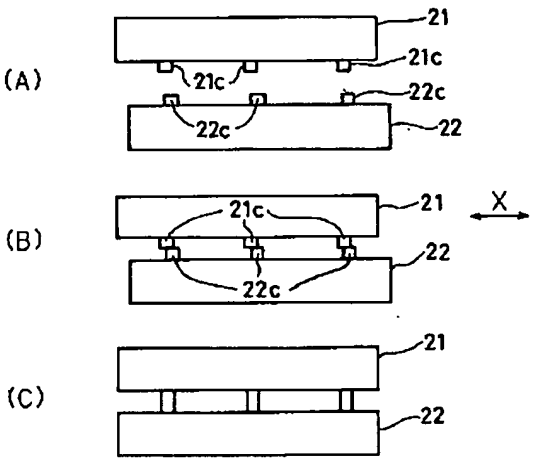
[Drawing 5]

本発明の第3実施例の斜視図



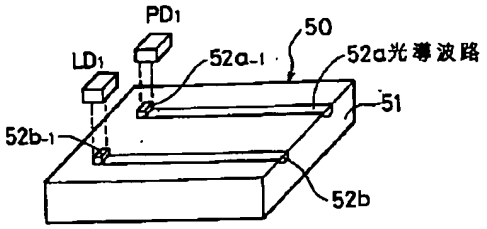
[Drawing 6]

本発明の第3実施例の光結合工程図



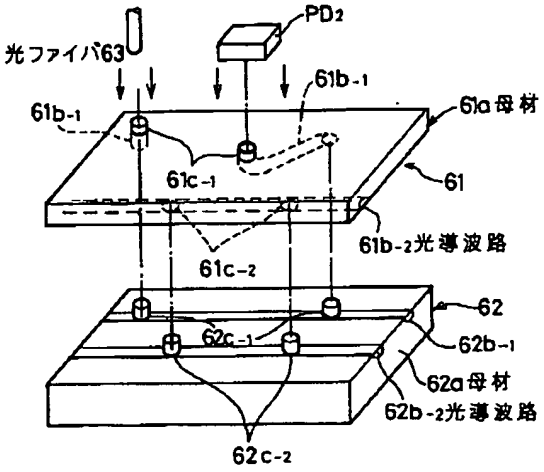
[Drawing 7]

本発明の第4実施例の斜視図



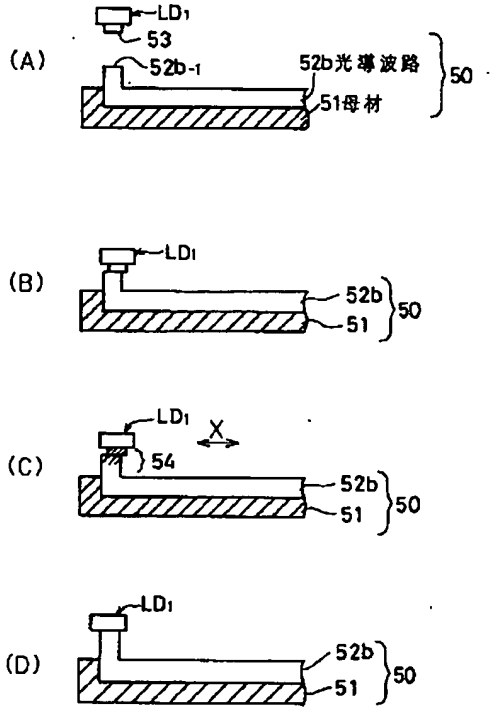
[Drawing 9]

本発明の第5実施例の斜視図



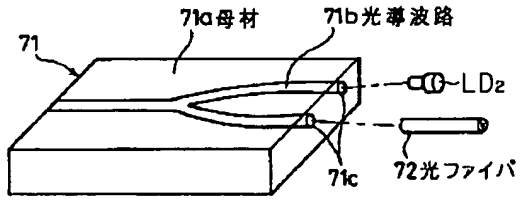
[Drawing 8]

本発明の第4実施例の光結合工程図



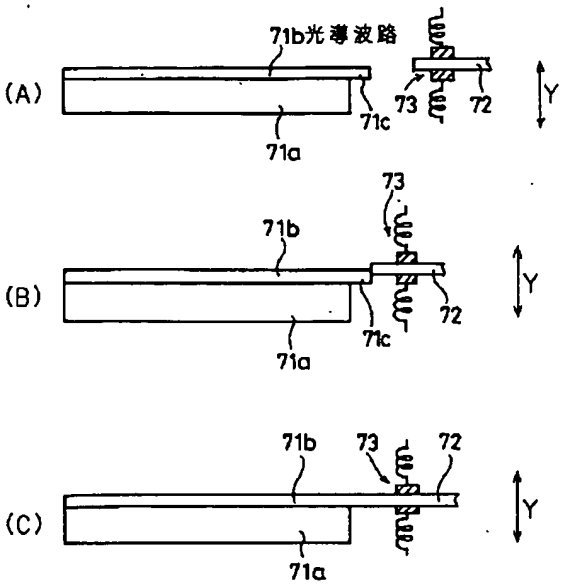
[Drawing 10]

本発明の第6実施例の斜視図



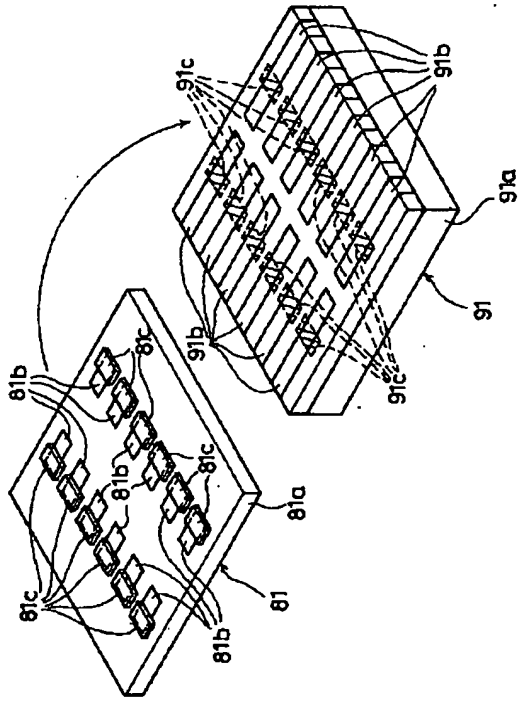
[Drawing 11]

本発明の第6実施例の光結合工程図



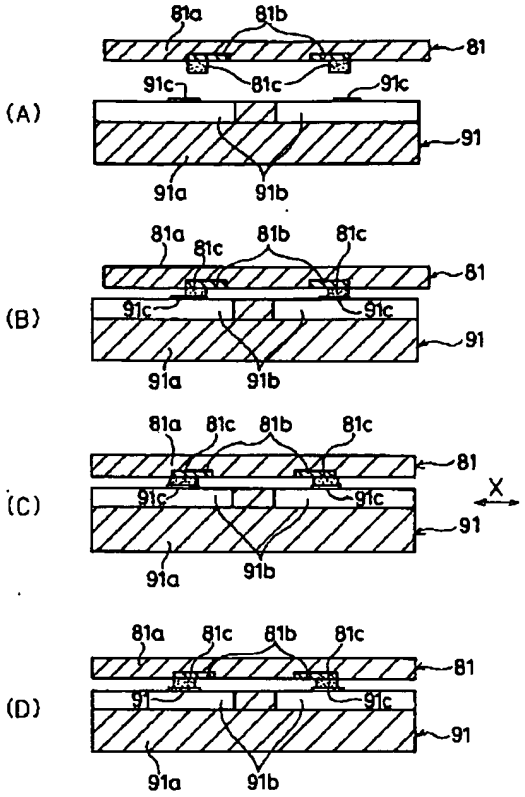
[Drawing 12]

本発明の第7実施例の斜視図



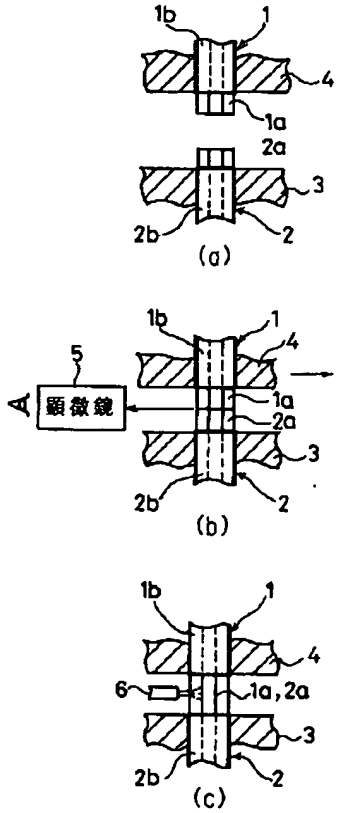
[Drawing 13]

本発明の第7実施例の光結合工程図



[Drawing 14]

従来の一例の工程図



[Translation done.]